Automatic Bridge Control for Ships Using PLC

Jagtap Neha[1], Jadhav Ashwini[2], Thorat Akanksha[3]
[1,2,3] *Electronics and Telecommunication Department, Maratha Vidya Prasarak Samaj's Karmaveer Adv. Baburao Ganpatrao Thakare College of Engineering, Nashik-13*

***Abstract*- Generally, in automation industry in real life it is a global need for ease of operation, flexibility and operational safety. This paper presents automation on controlling the movement of a bridge using a programmable logic controller. The idea is to automate the process of ship detection, opening or closing of a bridge, controlling the signals and road barriers. The purpose of the research is to replace the needs of today for low cost transportation. The Delta PLC is used to mechanize the system. Some Sensors such as IR Sensor, Ultrasonic Sensor are used to provide input to the system and servo motor serves as an actuator. Ladder diagram as a programming language is used to control the whole system between the input and for road traffic and water (ship) traffic. With the help of IR Sensor the arrival and leaving of the ship is monitored and bridge is operated accordingly and Ultrasonic sensor is used to detect the level of the water. In case of flood situation occurs, ultrasonic sensor indicates the high level of water.**

***Index terms*- PLC, Servo Motor, IR Sensor, Ultrasonic Sensor**

I.INTRODUCTION

In today's world, the need for transportation is very high, whether it is road transportation, water transportation or air transportation. For solving the problem of rivers between two cities, intelligent humans have built bridges to travel across the river. But it suppose that river is also used for water transportation, so obviously cargo ships will also passing through the river, but bridge used for road transportation on river are there, then how can big ships pass through that river?

To overcome this problem humans have built a bridge that can open and close. The river can thus be used for two type of transportation, namely road and water. This process has been accomplished by pulling levers or pushing buttons till now. But this method is not very safe, sometimes it can cause accidents. So proposed project presents an effective solution to this problem by automating the whole process.

A PLC is the heart of the system. A PLC monitors inputs, makes decisions based on its program, and controls outputs to automate a process. Various types of PLCs by various companies are available today like Siemens, ABB, Delta etc. Ship is detected by IR sensor which is placed on the edges of bridge. Sensor output provides input to the PLC and it'll control opening of bridge using Servo motor and road barrier according to programming. The Automatic Bridge Control System consists of three important parts. The first part is the PLC controller and second part is hardware. These practically comprise of hydraulic system, solenoid valve and actuator for controlling bridge opening, of bridge. The third part is the sensor. The sensor checks the presence of Ship and level of the water.

Fig. 1: Typical Bridge Model.

II. LITERATURE REVIEW

Acy M. Kottalil et al [2] in his Paper automatic railway gate control shows a procedure to open and close the railway crossing according to condition of the sensors which sense presence or absence of train. The main objective of this paper is to provide an automatic railway gate at a railway crossing replacing the gates operated by the human. These types of gates can be employed in an unmanned gate keeper level crossing where the probability of accidents is higher and reliable and flexible operation is required. Since,

the operation is automatic; error due to manual operation is prevented with the help of IR sensors .The arrival and leaving of the train is monitored and the gate is operated accordingly. For controlling the Gate servo motor is used. A servo is a mechanical motorized device that can be instructed to move the output shaft attached to a servo wheel or arm to a specific position. Inside the servo box there is a dc motor mechanically linked to a position feedback potentiometer, gearbox, electronic feedback control loop circuitry and a motor drive electronic circuit as shown in fig.2

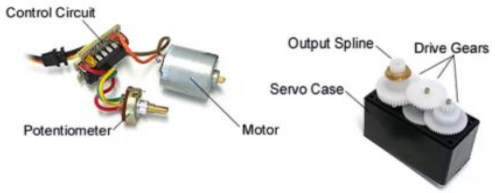

Fig. 2: Servo Components.

Servos are controlled by sending them a pulse of variable width. The control wire is used to send this pulse which controls the movement of a motor. The parameters for this pulse are that it has a minimum pulse width, a maximum pulse width, and a repetition rate. Given the rotation constraints of the servo, neutral is defined to be the position where the servo has exactly the same amount of rotation in the anticlockwise direction as it does in the clockwise direction. It is important to note that different servo motor will have different constraints on their rotation but they all have a neutral position, and that position is always approximately around 1.5 milliseconds. The angle is determined by the duration of a pulse that is given to the control wire.

When a pulse is given to a servo motor that is less than 1.5 ms then servo rotates to a position and holds its output shaft some number of degrees anti-clockwise from the neutral point. When the pulse is larger than 1.5 ms then opposite occurs. Generally the minimum pulse width will be approximately about 1 ms wide and the maximum pulse width will be 2 ms wide. This way servo motor rotates maximum 180 degree. It does not rotate continuously [2]. This motor is best for our application to operate road barrier

Muhammad Arshad Khattak et al [1] expressed his idea related to interfacing of Sensor with PLC in one of his paper. The main objective of their paper was to design and simulate an intelligent traffic control system. The system developed is able to detect the presence or absence of vehicles within certain range by setting the appropriate duration for the traffic signals to react accordingly.

By employing mathematical functions to calculate the appropriate timing for the green signal to ON, the system can help to solve the problem of traffic congestion. Hardware simulation tests were successfully performed on the algorithm implemented into a PLC.

A. Description

The PLC checks the status of the sensors. The system resolution is depend on the output provided by the sensors, Then PLC Checks the importance and then provides output signal to the traffic lights poles for ON or OFF the Red or Green lights and its ON time is dependent on the specific priorities. Block Diagram of the system is as shown in fig.3. The interface card is used between the sensors output and PLC for interfacing purpose. In this system card used is opto-coupler. When the input is detected by the sensor then a current limiting resistor is used for reducing the current and drops the voltage for a certain limit. When sensors provide output then a resistor is used in series with the opto-coupler [1].

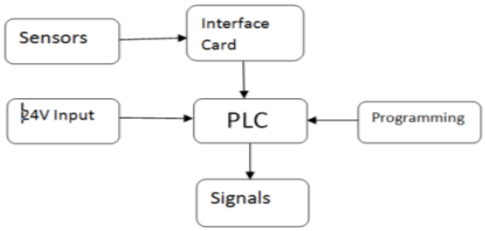

Fig. 3: Intelligent traffic control system

III.METHOD

A. Sensors and Components used:

1) Programmable Logic Controller:

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Fig. 4: Programmable Logic Controller

2) IR Sensor:

IR sensor is used to check the presence of ships. Here simple IR transmitter and receiver are used. When ship is detected by IR sensor it will send the signal to the PLC to open the bridge and when the ship is not detected by IR sensor it will send the signal to the PLC to close the bridge.

3) Ultrasonic Sensor:

Ultrasonic sensor is used to detect the low or high water level. It simply radiates the echo signal. An ultrasonic sensor uses a transducer to send and receive the ultrasonic pulses that relay back information about an objects proximity.

4) Signal Conditioning Circuit:

Signal conditioning is used to interface sensors with PLC. In signal conditioning Buck converter is used.

A DC-to-DC (BUCK) converter is an electronic circuit or electromechanical device that converts a source of direct current (DC) from one voltage level to another. It is a type of electric power converter. Power levels range from very low (small batteries) to very high (high-voltage power transmission).

A Buck converter (LM2596) steps down a DC voltage from the input to the output. The circuit operation depends on the conduction state of the MOSFET:

- On-state: The current through the inductor increases and the diode blocks.
- Off-state: Since the current through the inductor can't abruptly change the diode must carry the current so it commutates and begins conducting. Energy is transferred from the inductor to the capacitor resulting in a decreasing inductor current. During steady state the circuit is said to operate:

  In discontinuous conduction mode if the inductor current reaches zero and In continuous conduction mode if the inductor current never reaches zero.

The circuit has two limits of operation. For a PWM duty cycle $D \rightarrow 0$ the output voltage equals zero, and For $D \rightarrow 1$ the output voltage equals V_{in}. In between those limits the output voltage in continuous conduction mode is given by;

$$V_{out} = D \cdot V_{in}.$$

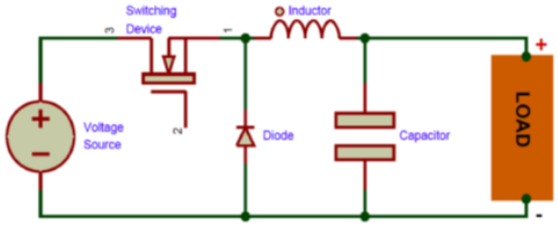

Fig.5: Buck Converter

5) Servo Motor:

Servo motor is used to open and close the bridge according to signal from IR sensor. Servo motor basically works on pulse of variable width. Generally the width of the pulse ranges from 1 ms to 2 ms, hence servo motor rotates maximum up to 180º and it cannot rotate continuously like DC motor.

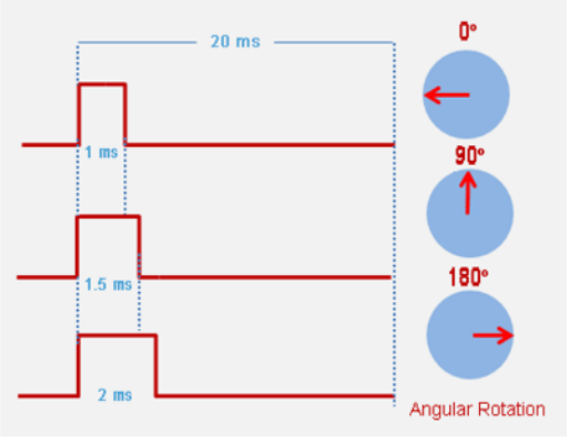

Fig. 6: Pulses of Servo Motor

6) Road Barrier:

Road barrier is used to indicate vehicle to stop. When ship would be detected, red light would be ON to indicate vehicle to stop because bridge will be about to open and when will ship pass through bridge, so after that bridge is closed then Green lights is turned ON again that means our ship is not going through the bridge.

7) Signal:
In the proposed system if the bridge is open then RED signal is used and if the bridge is closed then GREEN signal is used. Here RED and GREEN signal are simply light emitting diodes (LED).

8) Start Switch and Emergency Stop Switch:
Start switch is used to star the system and emergency stop switch is used when any emergency case occurs then at that instant system will completely stops.

III. PROPOSED SYSTEM

Firstly the system will start using start switch then IR Sensors is used to detect the ship. If ship is sensed by the sensor it gives the high pulse to the PLC. According to the sensor output, PLC will control the servo motor as well as road barrier. Servo motor is used for signal pole i.e. road barrier and also servo motor is used to move bridge up and down. Water level monitoring circuit will continuously monitor the level of water which may be high level or low level. According to bridge movement as well as water level the PLC will control the signals. If in case of emergency situation occurs then emergency stop switch will used to stop the system.

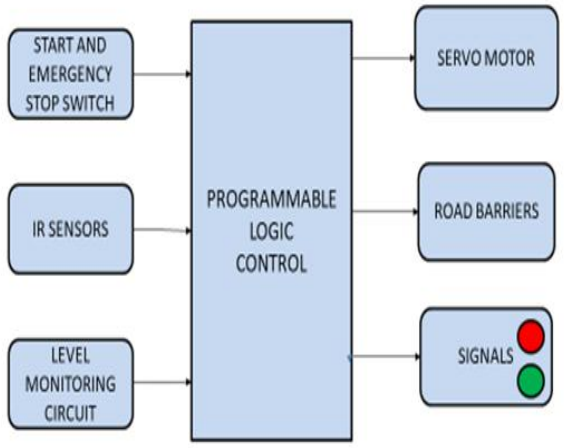

Fig. 7: Block Diagram.

IV. FLOW CHART

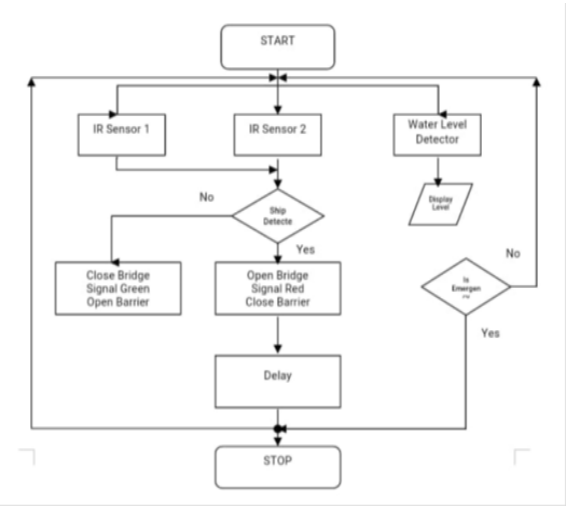

Fig.8: Flow Diagram

V. CONCLUSION

An automated bridge is designed with the help of a PLC based control system. The intelligence of the system is improved by the use of PLC .The automatic opening and closing of bridge increases the efficiency of bridge. Moreover the automation process reduces the involvement of man power. The process is less time consuming compared to human and also ensures safety.

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